

Installation for the cataphoretic dip coating of articles

The invention relates to an installation for the  
cataphoretic dip coating of articles, in particular vehicle  
5 bodies, comprising

- a) a dip tank, which is partially filled with a coating liquid, into which the articles can be immersed;
- 10 b) a coating voltage source, to the negative terminal of which the immersed articles can be connected and the positive terminal of which is connected with at least one anode immersed in the coating liquid present in the dip tank;
- 15 c) an electrodialysis apparatus, which is arranged outside the dip tank and by means of which the acid formed during the coating operation can be removed from the coating liquid, such that the acid content in  
20 the coating liquid remains within an admissible range.

In prior art installations for the cataphoretic dip coating of articles, the electrodialysis apparatuses, which ensured a substantially constant pH or conductance value of the  
25 coating liquid, were fitted inside the dip tank itself. The corresponding dialysis cells consisted of a housing, which bore an ion-exchange membrane which allowed anions to pass through, but was impermeable to cations and coating solids. The ion-exchange membrane here surrounded the anodes which  
30 were responsible for the cataphoretic coating operation. This design inevitably resulted in the anodes' being linear structures. However, since the articles to be coated themselves have an irregularly shaped outline, i.e. have

for example curved surfaces, in the stated known installations non-uniform electrical fields were obtained between the anode and the articles to be coated, with the consequence that the thickness of the coating over all the areas of the article to be coated could be kept constant only with difficulty. In order to avoid excessively high local current densities, coating speed moreover had to be limited.

10      Cataphoretically operated installations with the electrodialysis apparatus fitted in the dip tank had certain further disadvantages which have resulted in the electrodialysis apparatus being removed from the dip tank in more recent known installations and arranged outside  
15     said tank with its own voltage source. Examples of such installations of the above-stated type are described in DE 32 43 770 A1, JP 55-00 6452 A and JP 55-05 0493 A. However, relocating the electrodialysis apparatus outside the dip tank in these latter-stated installations did not change  
20     the anodes from being linear structures. These installations accordingly also exhibit the above-described disadvantages.

25      The object of the present invention is to develop an installation of the above-described type in such a manner that it is possible to achieve more consistent layer thicknesses on the articles to be coated and higher coating speeds.

30      This object is achieved according to the invention in that  
d)     the anode has a cross-sectional profile which, in at least one portion, is adapted as a curved surface to

the outline of the articles to be treated in such a manner that the anode follows the outline of said articles in approximately parallel manner.

5      The invention is based on the recognition that relocating the electrodialysis apparatus outside the dip tank permits an entirely new freedom in the design of the anode: these anodes can now in fact be curved in virtually any desired manner and shaped such that they are at an approximately  
10     constant distance from the surfaces to be coated of the articles. As a consequence, the current flux profile between the anode and the article to be coated is substantially uniform; local variations in coating current density are largely avoided. In this manner, it is possible  
15     to achieve not only more consistent layer thicknesses, but also greater coating speeds.

The anode is conveniently a U-shaped profile with two lateral portions and a lower portion which joins the  
20     lateral portions together. In this manner, the articles to be coated in the dip coating bath can be surrounded on three sides by the anode, with only the top remaining free so that the article can be immersed in the dip coating bath.

25     Since the surfaces to be coated of many articles, in particular of vehicle bodies, are convex when viewed from the outside, it is advisable in these cases for the lateral portions of the anode to be curved concavely when viewed  
30     from the articles.

At least in their upper part, the anodes can consist of sheet metal. This is comparatively low in cost and also ensures an even distribution of current densities.

- 5 At least in its lower part, the anode should consist of a material permeable to the coating liquid, so that the coating liquid in the space enclosed by the anode can communicate with the coating liquid present in the space outside the anode.

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Materials permeable to the coating liquid which may preferably be considered are wire mesh or screen netting, a grating or a plurality of mutually spaced rods.

- 15 In one particularly preferred embodiment of the invention, the anode consists at least in part of iridium-coated titanium. The situation is accordingly as follows: since, in a dip coating installation according to the invention, the electrodialysis apparatus is not arranged in the dip tank itself, the anode is no longer, as in prior art installations, protected from direct contact with the coating liquid and is thus at risk of corrosion. An anode consisting of iridium-coated titanium is not subject to such corrosion. This material moreover prevents anode material from passing into the coating liquid.
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An exemplary embodiment of the invention is illustrated in greater detail below in the drawing; the single Figure is a schematic diagram of an installation for the cataphoretic dip coating of vehicle bodies.

The installation comprises a dip tank 1 which is partially filled up to a certain level with coating liquid. The

vehicle bodies 4 to be coated are guided perpendicularly to the plane of the drawing by means of a conveying system, which is not shown, and are first immersed in the dip tank 1, coated therein in a manner yet to be described and then 5 moved on to rinsing stations, which are not shown in the drawing.

Cataphoretic coating in the dip tank 1 is carried out with the assistance of a coating current source 5, with the 10 negative terminal of which the vehicle body 4 is connected while passing through the coating liquid. An anode 6, which is connected to the positive terminal of the coating current source 5, is also immersed in the coating liquid of the dip tank 1. The precise design and configuration of 15 said anode 6 is described below.

A proportion of the coating liquid is continuously transferred from the dip tank 1 to an ultrafiltration unit 10. The retentate obtained in the ultrafiltration unit 10 20 is returned to the dip tank 1 via a line 11, while the permeate is transferred to a working container 13 via another line 12. The permeate collecting in said container is of the same ionic composition as the coating liquid in the dip tank 1, but contains no coating solids.

25 The permeate is taken from the working container 13 by means of a pump, which is not shown, and some is supplied via a line 15 as rinsing liquid to the various rinsing stations, which are not shown.

30 The permeate from the ultrafiltration unit 10 collecting in the working container 13 is additionally subjected to treatment by electrodialysis with the aim of depleting the

acid concentration and so maintaining the pH or conductance value of the permeate, and thus ultimately of the coating liquid, within predetermined limits. To this end, an electrodialysis cell 19 is provided, which is supplied, 5 again by means of a pump which is not shown, with some of the permeate from the ultrafiltration unit 10 collecting in the working container 13.

The internal structure of the electrodialysis cell 19 is 10 shown only very schematically in the drawing. The cell contains at least one ion-specific ion-exchange membrane 21 together with a cathode and an anode which are arranged on opposite sides of the ion-exchange membrane 21 and are connected to a dialysis voltage source. For clarity's sake, 15 the cathode, anode and dialysis voltage source are not shown in the drawing. The permeate supplied to the electrodialysis cell 19 flows through a chamber within the electrodialysis cell 19 which is delimited on one side by the ion-exchange membrane 21. Low-conductivity water is 20 supplied via a line 16 to the chamber of the electrodialysis cell 19 located on the opposite side of the ion-exchange membrane 21. On passing through the electrodialysis cell 19, said water is enriched in known manner with anions which have passed over from the permeate 25 through the ion-exchange membrane 21.

The water enriched in this manner is sent for waste water treatment via a line 26. The permeate, the acid content of which has been depleted, is on the other hand reintroduced 30 via another line 27 into the working container 13.

The anode 6 arranged in the dip tank 1 has a substantially U-shaped profile in a cross-section perpendicular to the

direction of motion of the vehicle bodies 4. The anode is composed of three portions 6a, 6b and 6c, which may all be produced from iridium-coated titanium. The portions 6a, 6b of the anode 6 located to the sides of the vehicle body 4 consist of sheet metal and are curved such that they follow the shape of the vehicle body 4 to be coated in approximately parallel manner. The lower portion 6c, which connects the lateral portions 6a, 6b of the anode 6, likewise follows the outline of the vehicle body 4 in this area in approximately parallel manner, but is produced from a wire mesh material. Alternatively, perforated sheets, screen or grating structures and parallel arrangements of bars may also be used at this point. What is vital is that, thanks to the lower portion 6c of the anode 6, it is possible for there to be a connection between the coating liquid located inside the anode 6 and that outside the anode 6.

The above-described coating installation operates as follows:

The vehicle bodies 4 are immersed in the coating liquid located in the dip tank 1 and are cataphoretically coated therein in the electrical field between them and the anode 6. Since the distance between the surfaces to be coated of the vehicle bodies 4 and the anode 6 is substantially constant at all points, the electrical field, in which coating takes place, is largely uniform in the vicinity of the vehicle body 4. In this manner, it is possible to achieve more uniform layer thicknesses and greater layer thicknesses in a shorter time than were hitherto possible.

After coating, the vehicle bodies 4 are lifted back out of the dip coating bath 1 and taken to the rinsing stations, which are not shown, where adhering coating liquid is rinsed off.

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The removal of pigments from the coating liquid in the dip tank 1 is compensated by the addition of corresponding pigments.

10 During cataphoretic coating of the vehicle bodies 4 in the dip coating bath 1, the acid content rises in the coating liquid and thus also in the permeate leaving the ultrafiltration unit 10. Once a predetermined nominal value is exceeded, permeate is circulated via the electrodialysis  
15 cell 19, where acid is removed from the permeate, so returning the pH or conductance value to the admissible range. The permeate, whose acid concentration has been reduced in this manner, passes via the rinsing stations, in which it is used as rinsing liquid, back to the dip tank 1,  
20 such that the acid depletion performed in the electrodialysis cell 19 has an effect there too.

Because the electrodialysis operation has been relocated out of the dip tank 1 and the anode 6 thus no longer needs  
25 to be surrounded by an electrodialysis cell, it is possible to adapt the anode 6 in the stated manner to the shape of the vehicle body 4 to be coated.